IS 7451-1 (2007): Reciprocating internal combustion engines - Vocbulary, Part 1: Terms for engine design and operation [TED 2: Automotive Primemovers]

BLANK PAGE

IS 7451 (Part 1) : 2007
ISO 2710-1 : 2000

भारतीय मानक

प्रत्यागामी आंतरिक दहन इंजन — पारिभाषिक शब्दावली

भाग 1 इंजन डिजाइन और प्रचालन शब्दावली

(पहला पुनरीक्षण)

Indian Standard

RECIPROCATING INTERNAL COMBUSTION ENGINES — VOCABULARY

PART 1 TERMS FOR ENGINE DESIGN AND OPERATION

(First Revision)

ICS 01.040.27; 27.020

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2007

Price Group 7

NATIONAL FOREWORD

This Indian Standard (Part 1) (First Revision) which is identical with ISO 2710-1 : 2000 'Reciprocating internal combustion engines — Vocabulary — Part 1: Terms for engine design and operation' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Automotive Primemovers, Transmissions, Steering Systems and Internal Combustion Engines Sectional Committee and approval of the Transport Engineering Division Council.

The sectional committee decided to align the Indian Standard with the corresponding International Standard wherever feasible and wherever the domestic considerations were not so intense so as to have standards different from the ISO Standards. This decision was taken with a view to upgrade the quality of the products in line with the International Standards.

This standard was first published in 1974. The first revision has been undertaken due to revision of base standard

Only the English language text in the International Standard has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the International Standard.

The following technical changes have been incorporated:

a) Title and scope have been modified.
b) The following have been included:
   1) Pilot injection engine (**3**);
   2) Multi-fuel engine (**4**);
   3) Adiabatic engine (**5**);
   4) Accumulator injection, pilot injection (**6**);
   5) Working medium (**7**);
   6) Pressure wave charging; constant pressure; pressure charging; two stage pressure charging; surge; surge line; turbocharger efficiency; equivalent area of turbine nozzle have been included (**8**);
   7) Ignition timing, diesel knock, detonation (**9**);
   8) Effective compression volume; effective cylinder volume, bumping clearance, number of cylinders, connecting rod ratio, valve timings (**10**);
   9) Unidirectional engine, direct reversing engine, turbocompound engine (**17**); and
   10) Various types of engines based on cylinder arrangement (**18**).
c) New clauses have been added.
   1) Airflow (**8.5**);
   2) Engine speed (**11**), Torque (**12**), Power (**13**), Consumption (**14**), Pressures (**15**); and Temperatures (**16**).

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Indian Standard

RECIPROCATING INTERNAL COMBUSTION ENGINES — VOCABULARY

PART 1 TERMS FOR ENGINE DESIGN AND OPERATION

(First Revision)

1 Scope

This part of ISO 2710 defines the basic terms relating to the design and operation of Reciprocating Internal Combustion (RIC) engines.

Further terms relating to components and systems of RIC engines are defined in the nine parts of ISO 7967, and the performance is defined in the seven parts of ISO 3046.

NOTE For the translation of the terms into a language other than English, French or Russian, the terms commonly applied in the particular country shall be used.

2 Main definition

2.1
reciprocating internal combustion engine
a mechanism delivering shaft power by the conversion of fuel chemical energy into mechanical work during combustion in one or more cylinders in which working pistons reciprocate

NOTE When such a mechanism does not deliver shaft power but power in the form of hot gas, the mechanism is known as a free piston gas generator.

3 Definitions for reciprocating internal combustion engines classified by ignition method

3.1
compression ignition engine
an engine in which air is compressed and fuel injected near the end of the compression stroke ignition being obtained solely from the temperature of the cylinder contents, resulting from their compression (self-ignition)

3.2
hot bulb engine
an engine in which ignition is obtained by the temperature of the cylinder contents, resulting not solely from their compression but also from a local hot surface

3.3
engine with externally supplied ignition
an engine in which fuel is supplied in gaseous form and mixed with air outside the cylinder, ignition being obtained by a device in the combustion chamber supplied with energy from a source situated outside the cylinder

3.3.1
spark ignition engine
an engine in which ignition is obtained by means of an electric spark

NOTE In some countries this engine is also known as an "Otto-engine".

3.4
convertible engine
an engine which is so designed and equipped that, by some small changes to the construction of the engine, it can be converted from a compression ignition engine into a spark ignition engine and vice versa

NOTE In some cases, the term "convertible engine" means an engine converted from its original purpose to another purpose.

3.5
pilot injection engine
an engine in which a small quantity of liquid fuel is injected into the cylinders to initiate combustion

4 Reciprocating internal combustion engines classified by fuel type

4.1
liquid-fuel engine
an engine which operates on a fuel that is liquid at standard ambient conditions

4.1.1
diesel engine
compression ignition engine
a compression ignition engine in which air is compressed and liquid fuel (oil) is introduced into each cylinder near the end of this compression

4.1.2
spark ignition engine with carburettor
carburettor engine
a spark ignition engine in which suitable mixture of air and fuel formed outside the cylinder in device called a carburettor

4.1.3
spark ignition engine with fuel injection
a spark ignition engine in which fu is injected either into the air intak manifolds or into the cylinders

4.1.4
multi-fuel engine
an engine so designed an equipped that without modificatio it can operate on fuels of widely dif ferent ignition properties

4.2
gas engine
an engine which operates basically on gaseous fuel

4.2.1
pilot injection gas engine
a compression ignition engine in which a mixture of gaseous fue and air is compressed and ignited by the pilot injection of a small quantity of liquid fuel

4.2.2
spark ignition gas engine
a gas engine in which ignition occurs by means of an electric spark

4.3
dual-fuel engine
an engine which can operate either as a gas engine, as a pilot injection engine or as a diesel engine

5 Reciprocating internal combustion engines classified by cooling method

5.1
liquid-cooled engine
an engine in which the cylinders and cylinder heads are directly cooled by liquid

NOTE The term "water-cooled engine" is also used when the liquid is predominantly water. The term "oil-cooled engine" is used when the liquid is lubricating oil only.

5.2
air-cooled engine
an engine in which the cylinders and cylinder heads are directly cooled by air

5.3
adiabatic engine
an engine in which heat-loss from the cylinder and piston area is minimized by means of insulation

NOTE It is impossible to achieve the theoretical adiabatic process in practice. For this reason manufacturers frequently use the term "heat tight engine".

6 Fuel supply

6.1
injection of fuel
introduction, under pressure, of fuel into the combustion air

6.1.1
air injection
injection of liquid fuel into the cylinder by means of high pressure air

6.1.2
mechanical injection
injection of fuel solely by raising the fuel pressure until a valve opens

NOTE For mechanical injection using liquid fuel, the term "solid injection" is also used.

6.1.3
direct injection
an injection system in which fuel is injected into an open combustion chamber or the main part of a divided combustion chamber

6.1.4
indirect injection
an injection system in which fuel is injected into a divided combustion chamber

6.1.5
accumulator injection
an injection system in which fuel is injected by means of pressure from an accumulator, created before or during the operation of a fuel pump

6.1.6
pilot injection
an injection system in which a small quantity of fuel is injected to start the combustion process and thus obtain smoother combustion with lower peak pressures when the main combustion occurs

NOTE This is also called "pre-injection".

6.2
induction of fuel
supply into the working cylinder of a mixture of fuel and air, formed outside the cylinder

7 Working cycle

7.1
working cycle
a complete series of changes in the parameters of the working medium (mass, volume pressure and temperature etc.) present in each cylinder of a reciprocating internal combustion engine, accomplished before repetition occurs

7.1.1
working medium
mixture of air, or air and fuel, and/or combustion products, present in the cylinder during the working cycle

7.2
four-stroke cycle
a working cycle which, for completion, needs four successive strokes of a working piston of a reciprocating internal combustion engine

7.2.1
four-stroke engine
an engine which works on the four-stroke cycle

7.3
two-stroke cycle
a working cycle which, for completion, needs two successive strokes of a working piston of a reciprocating internal combustion engine

7.3.1
two-stroke engine
an engine which works on the two-stroke cycle

8 Gas exchange

8.1
natural aspiration
where the air (or air-fuel mixture) is caused to flow into a working cylinder solely by the difference between atmospheric pressure and the pressure in the cylinder

8.2
pressure-charging
where the air (or air-fuel mixture) is caused to flow into a working cylinder at a pressure raised above atmospheric pressure in order to increase the mass of charge and thus make it possible to burn more fuel

8.2.1
tuned intake pressure charging
a pressure-charging system in which the fresh charge is precompressed by a pressure wave resulting from tuned resonance oscillations in the intake duct

8.2.2
independant pressure charging
pressure-charging in which the fresh charge is precompressed by means of a compressor which receives its power from a source other than the engine to be charged

8.2.3
mechanical pressure charging
pressure-charging in which the fresh charge is precompressed by means of a compressor driven mechanically (for example: by gears or chains) from the engine to be charged.

NOTE This is often called "supercharging".

8.2.4
turbocharging
pressure-charging in which the fresh charge is precompressed by means of a compressor driven by a turbine fed by the exhaust gas of the engine to be charged

8.2.5
pressure wave charging
pressure-charging in which the fresh charge is compressed by means of a compressor driven by a turbine fed by the exhaust gas of the engine to be charged

8.2.6
constant pressure, pressure charging
pressure-charging in which the exhaust ports are connected to a single exhaust manifold, the design of which ensures that its pressure is virtually constant

8.2.7
two-stage pressure charging
pressure-charging in which a fresh charge is precompressed by means of two compressors which act on the charge one after the other to raise its pressure to a higher value than could be achieved with just one compressor

8.2.8
surge
operating point at which the compressor of a pressure charger is unable to maintain a steady airflow at a given pressure ratio

NOTE Reversal of the airflow gives a characteristic sound.

8.2.9
surge line
envelope of the points where surge occurs

8.2.10
turbocharger efficiency
adiabatic output power divided by the actual input power

8.2.11
equivalent area of turbine nozzle
a figure specified for each particular design of turbocharger which affects the speed, and thus the pressure ratio, of a turbocharger

8.3
charge cooling
cooling of the charge after compression in a pressure-charger and before entering the working cylinder

8.4
scavenging
expulsion of combustion gases from the working cylinder by a fresh charge admitted through the inlet valves or ports while the exhaust valves or ports are still open

8.4.1 Type of scavenging of two-stroke engines

8.4.1.1
uniflow scavenging
axial flow scavenging occurring when the inlet ports and the exhaust ports are at the opposite ends of the working cylinder

8.4.1.2
cross scavenging
transverse flow scavenging, occurring when the inlet ports and the exhaust ports are at the same end of the working cylinder and are substantially on opposite sides of the cylinder

8.4.1.3
loop scavenging
transverse flow scavenging, occurring when the inlet ports and the exhaust ports are at the same end of the working cylinder and are on the same side of the cylinder

8.4.2 method of scavenging

8.4.2.1
crankcase scavenging
a method of scavenging in which a fresh charge is induced into the cylinder by compression in the crankcase by the crankcase side of the working piston

8.4.2.2
scavenging by blower
a method of scavenging in which a fresh charge is supplied by a blower

8.4.2.3
exhaust pulse scavenging
a method of scavenging in which the expulsion of gases from the working cylinder is assisted by low exhaust pressure resulting from the low pressure part of the pressure pulse cycle in the exhaust manifold

8.5 Airflow

8.5.1
specific air consumption
quantity of air entering the working cylinders per unit of power and time

8.5.2
overall air/fuel ratio
quantity of air entering the working cylinders divided by the quantity of fuel supplied to the engine during the same period of time

8.5.3
trapped air/fuel ratio
quantity of air trapped in a cylinder before combustion divided by the quantity of fuel supplied to the cylinder for one working cycle.

NOTE For liquid-fuel engines, air-fuel ratios are expressed as ratios of mass. For gas engines air-fuel ratios may be expressed as ratios of volume at the same temperature and pressure.

8.5.4
delivery ratio
mass of fresh charge supplied to a cylinder for one working cycle divided by the mass of fresh charge corresponding to the piston swept volume at the pressure and temperature conditions in the charge air manifold.

8.5.5
trapping efficiency
mass of fresh charge trapped in a cylinder before combustion divided by the mass of fresh charge supplied to the cylinder for one working cycle

8.5.6
charging efficiency
mass of fresh charge trapped in a cylinder before combustion divided by the mass of fresh charge corresponding to the piston swept volume at the pressure and temperature conditions in the charge air manifold

NOTE The charging efficiency is equal to the product of the delivery ratio and the trapping efficiency.

8.5.7
charge flow
mass of fresh charge supplied to a cylinder per unit of time

8.5.8
theoretical charge flow
nominal gas flow
theoretical mass of fresh charge supplied per unit of time corresponding to the piston-swept volume at the pressure and temperature conditions in the charge air manifold

8.5.9
scavenging efficiency
mass of fresh charge trapped in a cylinder before combustion divided by the sum of the mass of fresh charge trapped in a cylinder before combustion and the mass of residual gas from previous working cycles remaining in a cylinder after closing the exhaust port

8.5.10
relative total charge
sum of the mass of fresh charge trapped in a cylinder before combustion and the mass of residual gas from previous working cycles remaining in a cylinder after closing the outlet port divided by the mass of fresh charge corresponding to the piston-swept volume at the pressure and temperature conditions in the charge air manifold

8.5.11
charging pressure ratio
ratio of the mean pressures of the charge air behind and before the pressure charger

8.5.12
rich mixture
an air-fuel mixture that contains more fuel than that theoretically required for complete combustion

8.5.13
lean mixture
an air-fuel mixture that contains more air than that theoretically required for complete combustion

8.5.14
stratified engine mixture
a mixture which is richer nearer the ignition plug and leaner further away

8.5.15
stoichiometric mixture
a mixture that contains exactly the theoretically required air-fuel ratio for complete combustion

8.5.16
excess air ratio
actual air-fuel ratio divided by the stoichiometric air-fuel ratio

8.5.17
swirl
rotational flow of gas around the central axis of the cylinder

8.5.18
swirl ratio
ratio of the swirl revolutions/minute to the engine revolutions/minute

8.5.19
squish
rotational flow of gas inwards to the centre of the piston and downward into the piston bowl as the piston rises

9 Combustion chamber

9.1
combustion chamber
a space in which ignition and combustion occur

9.2
open combustion chamber
a combustion chamber which is not divided

9.3
divided combustion chamber
a combustion chamber divided into parts (main part and subsidiary parts) in such a way that communication between them is restricted

9.3.1
prechamber
subsidiary part of a divided combustion chamber into which the fuel is injected, communicating through one or more comparatively narrow passages with the other part of the combustion chamber

9.3.2
whirl chamber
subsidiary part of a divided combustion chamber into which fuel is injected, communicating through one large passage with the other part of the combustion chamber and designed to give a controlled swirl to the working medium

NOTE A chamber of this type is also known as a "swirl chamber".

9.3.3
air chamber
subsidiary part of a divided combustion chamber into which fuel is not injected, and communication with the other part of the combustion chamber is restricted

9.4
piston chamber
part of the combustion chamber situated in the piston

9.5
ignition timing
instant in the engine cycle when sparking is initiated on the ignition plug of a spark ignition engine, generally expressed by the number of degrees of crank angle before top dead centre

9.6
diesel knock
noise caused by an uncontrolled extreme rate of pressure rise which occurs at the beginning of combustion

9.7
detonation
an abnormally high rate of pressure rise during combustion

10 Engine data

10.1 Dimensional data

10.1.1
cylinder bore
nominal inner diameter of the working cylinder

10.1.2
piston area
area of a circle of diameter equal to the cylinder bore

NOTE For an engine in which a piston rod passes through the combustion space, this area must be reduced by the area of the cross-section of the piston rod.

10.1.3
stroke
nominal distance through which a working piston moves between two successive reversals of its direction of motion

10.1.4
dead centre
position of the working piston and the moving parts which are mechanically connected to it at the moment when the direction of the piston motion is reversed (at either end-point of the stroke)

10.1.4.1
bottom dead centre
dead centre when the piston is nearest to the crankshaft

10.1.4.2
top dead centre
dead centre when the piston is farthest from the crankshaft

NOTE In engines with only one piston in each cylinder, the expression "outer dead centre" is sometimes used instead of "top dead centre" and "inner dead centre" instead of "bottom dead centre". However, for opposed-piston engines and free-piston engines, it is common to use those expressions in the opposite sense. Only the terms defined in 10.1.4.1 and 10.1.4.2 should be used.

10.1.5
stroke/bore ratio
ratio of the numerical values of stroke and bore

10.1.6
nominal volume
volume calculated from the nominal dimensions

NOTE Nominal volumes are mainly used for mechanical but not for thermodynamic calculations.

10.1.6.1
nominal clearance volume
nominal volume of the space on the combustion side of the piston at top dead centre

NOTE When applicable, this volume includes both parts of a divided combustion chamber.

10.1.6.2
piston-swept volume
nominal volume generated by the working piston when travelling from one dead centre to the next one, calculated as the product of piston area and stroke

NOTE In opposed-piston engines, the piston-swept volume is defined as the sum of these nominal volumes for the pistons in one cylinder.

10.1.6.3
nominal cylinder volume
nominal volume of the space on the combustion side of the piston at bottom dead centre

NOTE The nominal cylinder volume is equal to the sum of the nominal clearance volume and the piston-swept volume.

10.1.6.4
engine-swept volume
sum of all the piston-swept volumes of the engine

NOTE This volume is sometimes known as the "cylinder capacity".

10.1.6.5
engine cylinder volume
sum of all the nominal cylinder volumes of the engine

10.1.6.6
nominal compression ratio
numerical value of the nominal cylinder volume divided by the numerical value of the nominal clearance volume

10.1.7
effective compression volume
numerical value of the effective cylinder volume divided by the numerical value of the effective clearance volume

10.1.7.1
working medium volume
effective volume occupied by the working medium on the combustion side of the piston at a given point of the cycle

NOTE For a double-acting engine, the volume on each side of the working piston is considered separately. For an opposed-piston engine, it is the volume between the pistons that is considered.

10.1.7.2
effective cylinder volume
maximum working medium volume

10.1.7.3
effective clearance volume
minimum working medium volume

NOTE This volume is also known as the "compression space volume".

10.1.7.4
bumping clearance
distance between the lower surface of the cylinder head and the upper surface of the piston crown when the piston is at top dead centre

NOTE This volume is also known as the "top clearance".

10.1.8
number of cylinders
number of working cylinders of a reciprocating internal combustion engine

NOTE If one combustion chamber serves several working cylinders, these count as one working cylinder. If several combustion chambers are contained by one working cylinder it counts as one working cylinder.

10.1.9
connecting rod ratio
ratio of the crank radius to the distance between the centres of the bores of the connecting rod big and small ends

10.1.10
valve timing
beginning and end of the valve motion, generally expressed in degrees of crank angle from a designated dead centre

11 Engine speed

11.1
engine speed
number of revolutions of the crankshaft in a given period of time

NOTE In the case of free-piston engines the speed is the number of cycles per minute of the reciprocating parts.

11.1.1
maximum continuous speed
maximum engine speed at which the engine is allowed to run continuously at the continuous power declared by the manufacturer for a particular application

11.1.2
declared speed
engine speed at which the engine delivers the declared power

11.1.3
overload speed
engine speed at which the engine delivers the overload power declared by the manufacturer

11.1.4
idling speed
steady state engine speed without load

NOTE This is also known as the "no load speed".

11.1.5
firing speed
engine speed to which an engine must be accelerated from rest, by the use of an external supply of energy separate from the fuel feed system before it become self-sustaining

11.2
mean piston speed
mean velocity of the piston, calculated as twice the product of the stroke and the engine speed

12 Torque

12.1
torque
brake torque
turning moment delivered by the engine at a driving shaft

12.2
breakaway torque
driving torque that has to be applied to the flywheel or the crankshaft to overcome the static frictional resistance of the main running gear and of the essential dependent auxiliaries at the beginning of rotation

NOTE The preferred term should be "static friction torque". "Unsticking torque" is also used.

12.3
cranking torque
sum of cranking resistance torque and acceleration torque

12.3.1
cranking resistance torque
driving torque required to overcome the frictional resistance of the main running gear, the working cycle losses and the torque required by the essential dependent auxiliaries in order to maintain a constant engine speed after a given period of time from the beginning of rotation

12.3.2
acceleration torque
torque required to accelerate the main running gear and the essential dependent auxiliaries during the speed acceleration period from the beginning of rotation

13 Power

13.1
indicated power
total power developed in the working cylinders as a result of the pressure of the working medium acting on the pistons

13.1.1
indicator diagram
a diagram representing the variation of pressure of the working medium in a cylinder throughout a working cycle

13.2
brake power
power or the sum of the powers measured at the driving shaft or shafts

13.2.1
brake mean effective pressure
work done per working cycle corresponding to the brake power divided by the engine swept volume

13.2.2
brake thermal efficiency
brake power divided by the rate of supply of heat energy to an engine as fuel

NOTE The heat energy of the fuel should be considered as the product of the mass of fuel and its lower calorific value.

13.3
mechanical efficiency
brake power divided by the indicated power

13.4
load
a general term describing the magnitude of the "power" or "torque" demanded from the engine by its driven machinery and usually expressed relative to a declared power or torque

NOTE The term "load" is physically imprecise and should be avoided. For quantitative purposes, the terms "power" or "torque" should be used instead of "load", together with a statement of speed.

13.5
friction power
power necessary to overcome mechanical friction and to supply energy for all essential dependent auxiliaries

13.6
indicated thermal efficiency
ratio of the indicated power to the rate of supply of heat energy to an engine as fuel

13.7
heat emission
heat emitted from an engine by radiation, convection and conduction into the surrounding atmosphere

14 Consumption

14.1
fuel consumption
quantity of fuel consumed by an engine per unit of time

14.2
specific fuel consumption
quantity of fuel consumed by an engine per unit of power and time

NOTE While for engines which burn liquid fuel, the fuel consumption and specific fuel consumption are normally expressed in terms of the mass of fuel, for gas engines it is normal to quote fuel consumption either in units of energy or as a volume at a specific temperature and pressure, together with the calorific value of the fuel.

14.3
lubricating oil consumption
quantity of lubricating oil consumed by an engine per unit of time

14.4
specific lubricating oil consumption
quantity of lubricating oil consumed by an engine per unit of power and time

14.5
heat consumption
rate of supply of heat energy to an engine per unit of time

NOTE Heat consumption is calculated as the product of fuel consumption (14.1) and lower calorific value.

14.6
specific heat consumption
rate of supply of heat energy to an engine per unit of power and time

NOTE The specific heat consumption is given a subscript according to the kind of power to which it refers.

15 Pressures

15.1
compression pressure in a cylinder
maximum pressure of the working medium present in a cylinder, at momentary fuel cut off or ignition switch off

15.2
maximum cylinder pressure
maximum pressure of the working medium present in a cylinder attained during a working cycle

NOTE This pressure is also known as "peak pressure".

15.3
ambient pressure
pressure level of the atmosphere in the vicinity of where the engine takes its air

15.4
inlet pressure
arithmetic mean absolute intake pressure at engine or pressure charger inlet

15.5
boost pressure
arithmetic mean charge air pressure after a pressure charger

NOTE When the boost pressure is only slightly above atmospheric pressure, the term "scavenging pressure" is used in the case of two-stroke cycle engines.

15.6
exhaust back pressure
arithmetic mean of the pressure in the exhaust manifold or after the turbine

16 Temperatures

16.1
ambient temperature
temperature level of the atmosphere in the environment of the engine installation

16.2
inlet temperature
temperature of the air entering an engine measured at a specific point in the inlet ducting

16.3
minumum engine starting temperature
lowest site temperature at which an engine equipped with essential dependent auxiliaries can be brought to a self sustained speed under stated starting conditions within a given period of time after actuating the starting device

NOTE Fluid lubricants, fuels and coolants are anticipated. The value of this temperature depends on whether a starting aid is used. For engines without preheating the lowest site temperature assumes that the engine has been completely cooled down to this temperature.

16.4
exhaust temperature
mean temperature of the exhaust gas leaving the cylinder

17 Design arrangement

17.1
single-acting engine
an engine in which combustion takes place on only one and the same side of each working piston

17.2
double-acting engine
an engine in which combustion takes place alternately on either side of each working piston

17.3
opposed-piston engine
an engine, having in each cylinder two mechanically connected working pistons running in substantially opposite directions, with the working medium between them

17.4
trunk-piston engine
an engine in which each connecting rod is hinged directly to its working piston, which transmits to the cylinder wall the side thrust caused by angularity of the connecting rod

17.5
cross head engine
an engine in which the side thrust caused by the angularity of the connecting rod is transmitted through a linking mechanism (crosshead) to guides fixed outside the cylinder

17.6
unidirectional engine
an engine in which the crankshaft is designed to always rotate in the same direction

NOTE This can also be referred to as an "irreversible engine".

17.7
direct reversing engine
an engine in which the direction of rotation may be changed by the operation of a control device

17.8
turbocompound engine
an engine in which the power is generated by multistage expansion of the working medium in an RIC engine and a power turbine

18 Cylinder arrangement

18.1
cylinder row
an arrangement of cylinders in which the pistons are connected to the same crankpin of the crankshaft

18.2
cylinder bank
an arrangement of cylinders in which the centre line of the crankshaft journals lies in or is parallel to the plane containing the centre line of the engine cylinders, all cylinders being on the same side of the crankshaft

18.3
in-line engine
an engine with one cylinder bank

18.4
vertical engine
an engine with one or more cylinder banks each located in a vertical plane above its crankshaft

18.5
horizontal engine
an engine with one or more cylinder banks each located in a horizontal plane

18.6
inclined engine
an engine with one cylinder bank which is located in an inclined plane lying between the vertical and horizontal planes through the crankshaft

18.7
inverted engine
an engine with one or more cylinder banks each located in a vertical plane below its crankshaft

18.8
twin-bank engine
an engine with two parallel cylinder banks and two crankshafts

18.9
V-engine
an engine with two cylinder banks inclined at an angle to each other and with one crankshaft

18.9.1
V-angle delta
Δ
angle between two planes containing the centre lines of the engine cylinders perpendicular to the crankshaft

$(0° < \Delta < 180°)$

18.9.2
cylinder offset
distance measured parallel to the crankshaft, between the centre lines of two pistons on opposite sides of the V of the engine that have connecting rods that work on the same crank pin

18.10
horizontally opposed engine
an engine with two cylinder banks located in the same plane on opposite sides of the crankshaft

18.11
broad-arrow engine
an engine with more than two cylinder banks inclined at an angle to each other and with one crankshaft, the inclined angle between the extreme banks being less than 180°

NOTE A broad-arrow engine with three cylinder banks is known as a "W-engine".

18.12
X-engine
an engine with one crankshaft having four cylinder banks arranged in two planes, inclined at an angle to each other, the two banks in each plane being on opposite sides of the crankshaft

18.13
H-engine
an engine with two crankshafts having four cylinder banks in two parallel planes, the two banks in each plane being on opposite sides of a crankshaft

18.14
radial engine
an engine with more than two cylinders in each row equally spaced around the crankshaft

NOTE Cylinders may be in banks or if there are only two rows on the shaft they may be staggered. In which case they are said to be "star engines".

18.15
polygon engine
an opposed-piston engine with three or more cylinder banks inclined at an angle to each other so that the banks form the plane sides of a polygonal prism with a crankshaft at each corner of the prism

18.16
overhead-valve engine
an engine in which the valves are mounted in the cylinder head above the piston and close in the same direction as the piston movement towards top dead centre

18.17
side-valve engine
an engine in which the valves are mounted in the crankcase at the side of the piston and close in the same direction as the piston movement towards bottom dead centre

19 Free-piston engines

19.1
free-piston engine
a mechanism delivering power by the combustion of fuel in one or more cylinders in which working pistons reciprocate but where the power is not transmitted by a shaft

NOTE The pistons are nevertheless synchronised by a means that may not be mechanical.

19.2
free-piston gas generator
a free-piston engine in which the power is delivered in the form of hot gas

19.3
free-piston compressor
a free-piston engine in which the power is delivered in the form of compressed air

19.4
free-piston gas generator set
a combination of one or more free-piston gas generators with a mechanism which converts power in the hot gas into shaft power

Alphabetical index

R

S

T

U

V

W

X

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc: No. TED 2 (479).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *website* : www.bis.org.in

Regional Offices:		Telephones
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843, 260 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches: AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAJKOT. THIRUVANANTHAPURAM. VISAKHAPATNAM.

Printed at Simco Printing Press, Delhi